

# Climate control and heating systems in churches - strategies and experiences in Scandinavia during the last 100 years



- History of heating of churches
- Heating strategies during the 20th century in Scandinavia
- Heating strategies and climate control of today
- Heating in the future; climate changes and energy efficiency

# History of heating of churches

- Oldest churches in Scandinavia from the Middle Ages – unheated in 500-900 years
- Last 100 years:
  - ovens
  - electrical radiant heaters
  - hot water radiators
  - pew heating

# Use of churches in Scandinavia today: religious







Use of churches in  
Scandinavia today:  
tourists

# Heating strategies during the 20th century in Scandinavia

- Comfort main objective
- Damages in interiors and objects, especially in wooden polychrome objects, 1980's more systematically climate measurements
- Reasons:        heating during winters – dry climate  
                         changes in climate due to on/off-heating
- Heating strategies



# Heating strategies during the 20th century in Norway



- 1970-80's:
  - continuous low heating, increasing heat when necessary
  - humidifiers
- 1990's:
  - quick heating and cooling
- 2000's:
  - "zone-heating"
  - max 16 C when in use, 5-10 C when not in use
  - as few heating periods as possible
  - as short heating periods as possible
  - low heating during summers in areas with high humidity

# Heating strategies in Denmark

- Damages:    - drying-out of painted woodwork  
                  - salt crystallizing in murals



- Continuously heated churches: base-temperature 15°C, using-temperature 18°C, relative humidity 50-80%.  
Required where the church usually used more than 2-3 times a week, or where personnel must stay frequently in the church. Risk of too dry climate during winters, check the relative humidity – lower the temperature
- Periodically heated churches : base-temperature 8°C, using-temperature 18°C, relative humidity 50-80%.  
This is the normal kind of heating, used in most of the churches in Denmark.



# Heating strategies in Sweden

No direct recommendations, but advices of how to evaluate the heating situation in each church.

## 1. Comfort for people

- Normally comfortable max 16-18°C
- Periodically heated church, too cold for those who work in the church

## 2. The building and the objects

- A stable relative humidity, 50-70 %.
- Periodically heating limited to 6-12 hours, relative humidity under 50% accepted
- Avoid extremely high temperatures in some parts of the building
- As low "base temperature" as possible regulated by the relative humidity, but not under 0 °C.
- As low air flow as possible.
- Minimizing dust and soot in the air
- Avoid condensation, especially by not ventilating when it is warmer outside the building than inside.

# Heating of churches of today

- Not heated
- Periodically heated in the cold season
- Continuously heated
- Zone-heated
- Protection heated

Practice today in Scandinavia – periodically (and continuously) heating

# Heating systems of today

- Underfloor heating
- Convective heating, for example hot water radiators
- Pew heating
- Infrared heating
- Warm air heating

**A heating system shall heat the people, not the whole environment**

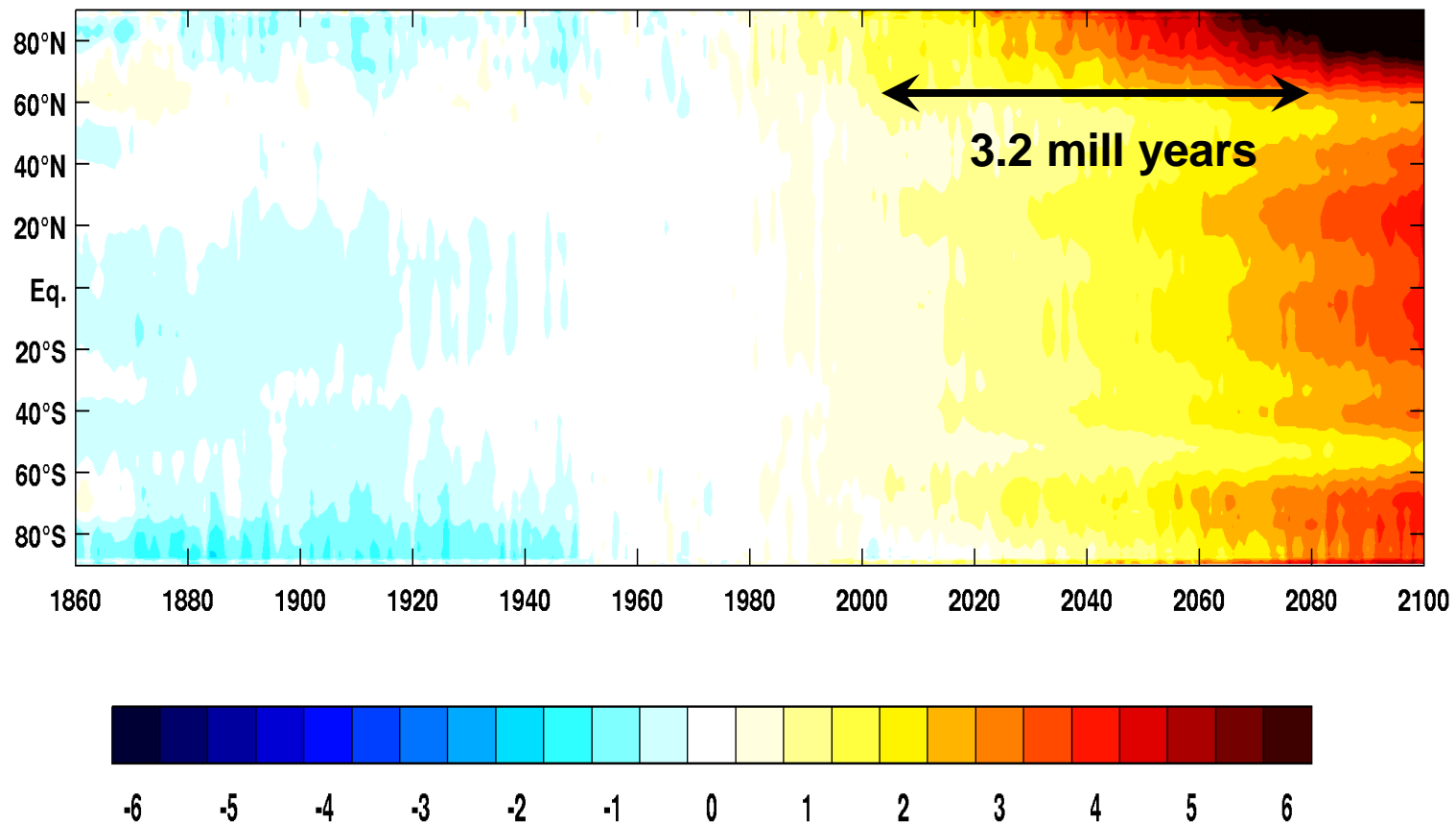




# Heating in the future – climate changes and consequences for the heating strategies

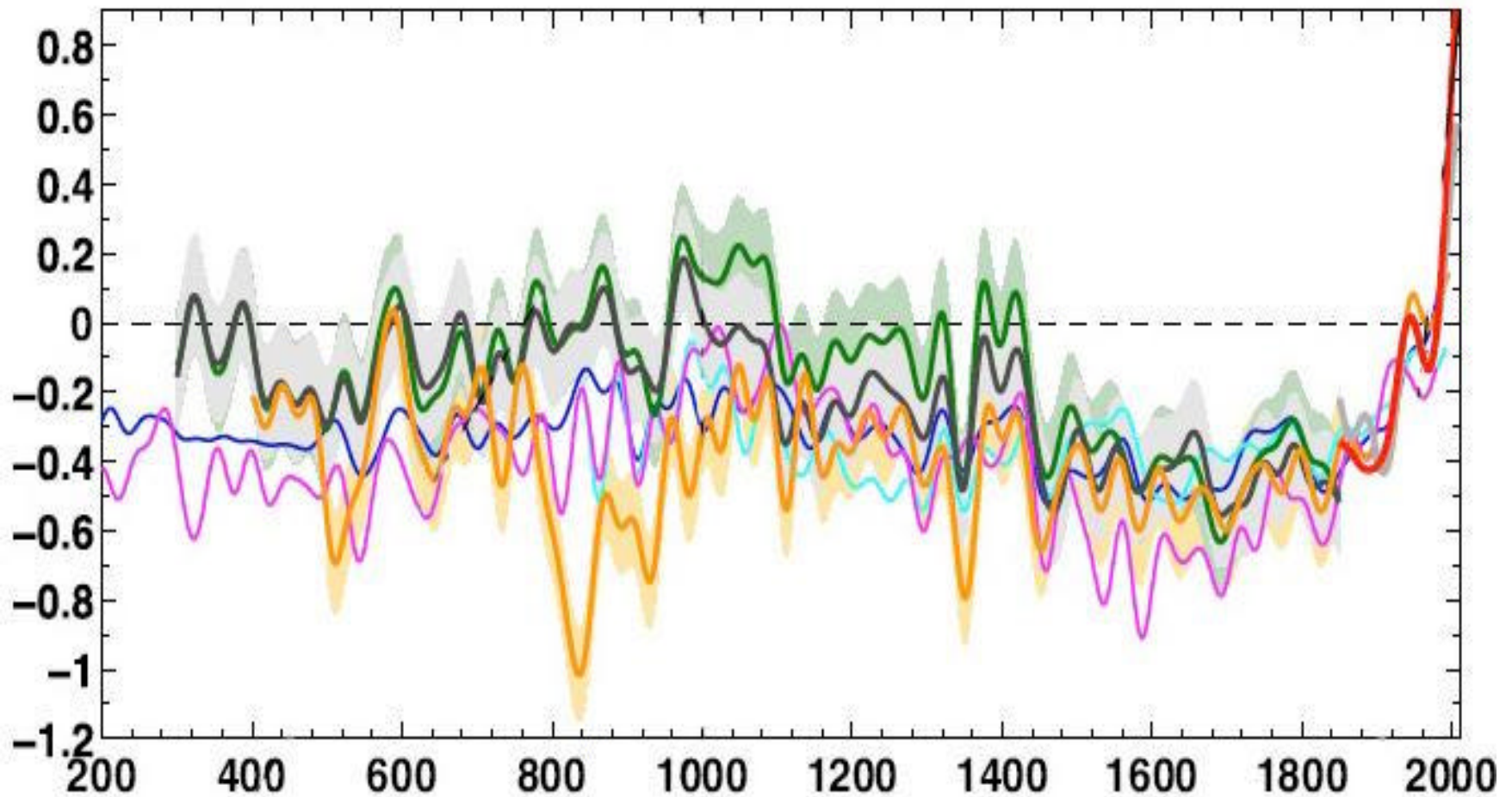


# Estimated increase of average temperature, 1860-2100

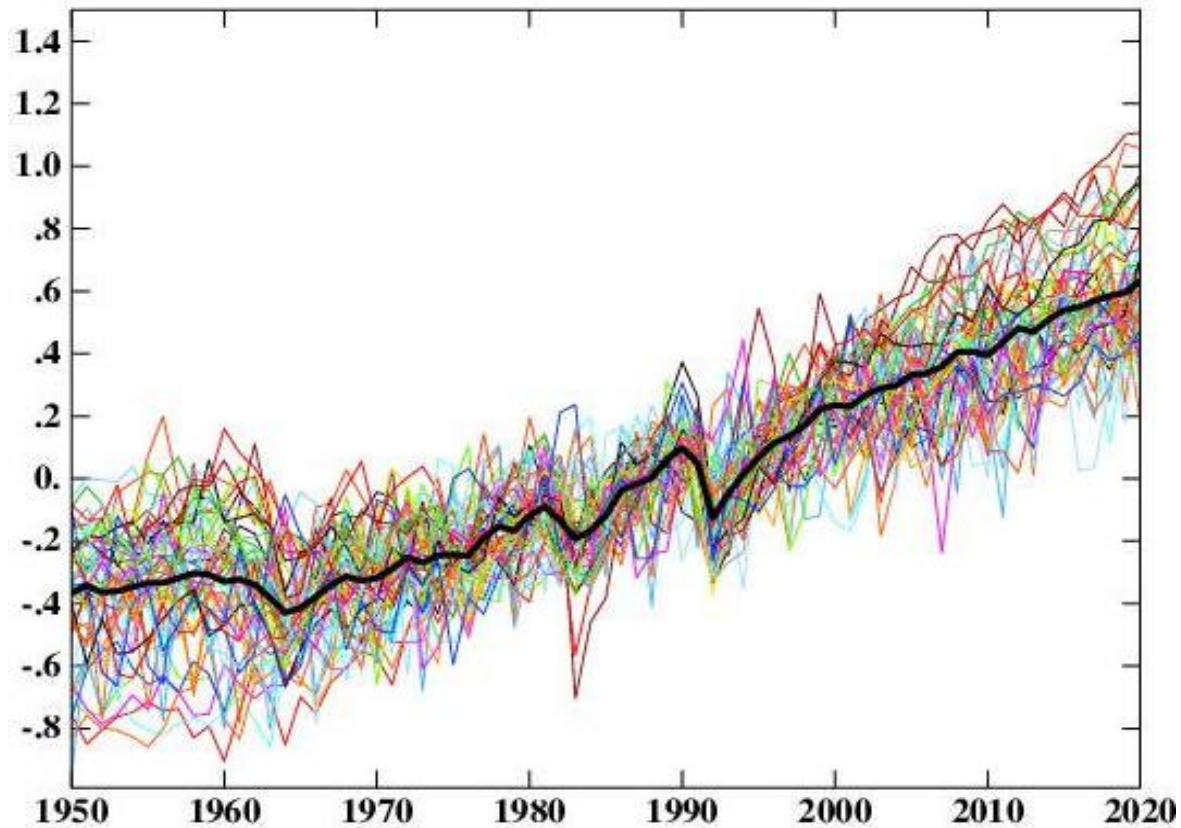


(Ensemble Mean IPCC 4AR, Scenario A2) Helge Drange, Geofysisk institutt, Universitetet i Bergen

# Observed and reconstructed climate on the northern part of the earth



# Climate changes / climatic variations



Helge Drange, Geofysisk institutt, Universitetet i Bergen



# Direct and indirect impact of the climate changes

- Direct impact:
  - rain / snow will increase in parts of Scandinavia
  - higher temperatures
  - increase of wind /storms
  - shorter winters
  - more floods
- Indirect impact: -higher humidity – heating necessary in other periods?
  - more energy efficient heating systems!
  - more energy efficient buildings!

# More energy efficient heating systems

- Which climatic conditions in the building are preferable?
- Which heating strategy?
- Which heating system exists today?
- Which energy source is used today?
- How is the system controlled?

# More energy efficient buildings

- lower temperature
- air flow
- change of use
- insulation
- ventilation
- windows
- monitoring

# Heating strategies in the future

- "Heat the people, not the building"
- "Energy-efficiency"
- "Saving energy + heating the people = saving the cultural heritage?"